SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

No. 1215.—Vol. XXVIII.] LONDON, SATURDAY, DECEMBER 4, 1858. [WITH JOURNAL] STAMPED.... SIXPENCE. UNSTAMPED. FIVEPENCE.

ON COPPER SMELTING.

BY HYDE CLARKE, C.E.

At the third ordinary meeting of the 105th session of the Society of Arts, held on Wednesday (Sir Thomas Phillips, Member of the Council, in the chair), the following paper was read :—

Copper smelting is of considerable importance in England, not only because we smelt our own Cornish and other ores, but because we have thereby a large business in smelting foreign ores and refining foreign copper, and which gives us a great command of the trade in manufactured copper; and as well by our own advantages as the deficiencies of our neighbours we obtain valuable results. Although the copper mines of England do not afford the rich ores of Lake Superior or the Burra Burra, they abound in low sulphuret ores, which are easily smelted; and with the benefit of very cheap fuel, we are able to undertake the smelting of the rich carbonate ores of other countries on better terms than they can do it themselves. Many countries rich in copper have dear or scarce fuel, and dear labour, and must import their bricks and furnace cements, and thus it is found better to export the ore to the fuel than to import fuel, and carry it to the ore. Rich ores, too, in many cases, are carbonates, which can be more conveniently smelted with the English sulphurets. Then, further, France, Belgium, and Holland, are almost destitute of copper mines, so that the English have an opening there for manufactured copper, and compete in Central Europe with the Russian copper, or supply those countries with bar-copper for refining.

With all these advantages, it is still to be questioned whether the English copper trade has reached its height, or is free from vicissitudes. To suit the circumstances of local business, a particular course of smelting by coal in reverberatory furnaces has been adopted; but this is not the most economical method, nor does it admit of the reduction of the lowest class of copper ores. It is quite possible, looking to the effective establishment of copper smelting in Chile, the United States, and Australia, to the abundant supply of rich copper ores abroad, and the competition of very cheap iron, that copper may be reduced in price, and thereby the working of the Cornish mines be threatened; but on the other hand, if processes be adopted for the more economical reduction of copper, ores of lower produce, or at lower rates, can then be brought to market, the reduction in price may be compensated. New combinations of copper, new alloys, as with silicium, will likewise open new sources of consumption.

At present, copper smelting is a routine work, pursued on the same plan as of old, and on the same general system in most of our works, followed out as a mechanical practice rather than as a scientific occupation; but the description of it is interesting, because it is continually undergoing modifications, which result in more economical working, without much affecting the general system. There are several accounts of copper smelting, among which are those by the late Mr. John Vivian, the head of the great smelting firm; by F. M. Le Play, one of the most eminent mining engineers in France, who has most minutely observed the processes; by Mr. Napier, the author of great improvements in smelting; by John Arthur Phillips, a member of this society, and by writers in the *Mining Journal*, but no account has been laid before this society, and I have, therefore, taken the opportunity, in contributing this account, to bring it up to the present day. It will be seen that, in the main, it will agree with the authorities referred to, but with the difference resulting from modifications which, formerly matters of theory and experiment, have now been more liberally adopted. There is, however, one inconvenience in such a paper, that it does not admit of the minute details which are necessary to give a complete view of the processes. Thus, Le Play has devoted a volume to the subject, describing each operation as closely as he could; and so, too, my own materials have to be abridged to meet the space which is disposable. It is much to be regretted, however, that we have not in English a work on this subject as copious as that of Le Play, with the requisite drawings on a large scale. To do so, however, requires, as in his case, the aid of a Government department.

The copper smelting trade began in Cornwall, and was thence removed to South Wales, which until lately remained its sole seat, as it is its chief seat; but Liverpool, having a great import of foreign and colonial copper ores and bar copper, has favoured the establishment of smelting works on the Mersey, and has a copper market, which is yearly growing in importance. The classes of copper ores chiefly produced in this country are sulphurets, which are made to average about 9 per cent. in the works. As sulphuret ores are more convenient for working in reverberatory furnaces, the smelters of South Wales and Liverpool are able to treat the carbonate ores from abroad, which are richer in copper, but less tractable than the sulphurets of copper.

The process of sampling copper ores in most of the copper countries of the world is now determined by the Cornish practice, which has been introduced, or, is worked, by Cornish samplers, or by Welshmen trained under them. This process has been sufficiently described in works relating to mining, and provides for the ore of each mine or class being broken up about the size of a French walnut—or, say, ¾ in.—and formed into a separate pile. It is desirable the pyramidal pile should not be more than about a yard high, and the slope of the sides the natural batter determined by the stuff. A small pile is cut through with the sampling spade in four sections, by trenches of about 8 in. wide in the base. The pile is cut thus—

a b
c d

But if a large pile, thus— a b c or a b c d
d e f e f g h

In each section, as for instance that of a, two portions are taken with the shovel from bottom to top of the inner pieces of the section at each end. All these sixteen scrapings are brought together, forming so many vertical sections of the pile, and well mixed and ground up, being gradually reduced by dividing the mass into 4.

a b, taking away a
c d d

and leaving only b and c, which are mixed, and again divided into four, when the process is repeated till the whole produce of the sampling is brought to a manageable weight, from which the small samples for assay are taken, and likewise a drying sample, to ascertain the proportion of moisture in the ore. Although a pile of copper ore under 100 tons is only divided into four, when above that quantity it is always further divided.

Copper regulus for sampling is broken to the same size as copper ore, but on account of the greater value of the article it is usual, unless the pile is a very small one, to divide it into six or more plots.

Argentiferous copper ore, or argentiferous copper regulus, is broken smaller, or even ground up, as there is a greater chance of variation in the average sample.

Abroad, where the ores are shipped in a rough state, and labour is not available for breaking up the ores, they are sampled by taking one bucket of ores in ten or twelve, and, reducing these to a small sample, by continued subdivision and substruction, as in the case of the Cornish process.

In shipping ores from abroad for the English market, the qualities of ores in bulk are separated by matting on board; but the richer ores, as silver ores, are shipped in small hide bags, of local make, or in bags of sacking sent out from this country, in which there is a considerable trade.

In sampling, much, with all the care that is taken, may be done by a little mechanical skill on the part of the sampler in handling and managing his shovel, and in taking and leaving richer bits of ore, which he knows by eye, to get such a sample as he wishes.

In the case of ores in all climates, or whether carried by land carriage or sea, there is always some proportions of moisture imbibed, which affects the nett weight, and is ascertained by a drying sample, which is tried in an oven, and reduced to a dry state, the difference of moisture being taken as the difference of weight.

This is not always the true difference, as other portions are volatilised besides water, and the difference is in favour of the smelting. In hot countries, ores are affected by heavy night dews, and by the muleteers wetting the ores on crossing streams. Ores in ships generally imbibe moisture.

It is to be observed that the drying sample is taken at a different time from the assay sample. The maximum moisture of foreign ores imported into Swansea is stated by Messrs. Richardson and Co., the eminent ore agents of that town, and by other local authorities, as follows:—

Chile ores	28 drams, or	6 to 11 per cent.
Cobre ores	36 „	15 „
Cuba precipitate	60 „	25 „
Rough Chile regulus	9 to 10 „	3 to 11 „
Rough copper ores	12 „	5 „
Fine copper ores	22 „	9 „

The minimum moisture abroad is—

Rough regulus	1½ drams, or	¾ per cent.
Rough ore	2 „	1 „
Fine ore	10 „	4 „

The process hereafter described is an ordinary course of working poor Cornish sulphurets, mixed with rich foreign carbonates; the furnaces being about 14 feet by 11 feet inside dimensions.

I.—Process of Calcining Ores.

The first course is to calcine the sulphurets, so as to get rid of some of the superfluous sulphur. There are many modes of effecting this. Where there is not a populous neighbourhood, the simplest mode, and one sufficiently effective, it is to roast the ores in the open air, in a pile, with brushwood or small coal. This is done, for instance, in the Alten Works, in Norway, belonging to the Alten and Quænangen Company.

In some works the calcining furnace is much the same as the other furnaces. In others it only varies by side doors being provided for rabbling, or spreading the charge over the hearth.

Messrs. Vivian, in some of their great works, use what are called baboons, an old form of calciner, fixed over the furnace, into which it discharges the calcined ore hot.

It is usual to make calciners with double beds, because as a lower heat is required than for melting, the flame can, after being used on the lower bed of ore, be made to play on the upper floor or bed. A charge of ore is commonly laid on the top of the calciner in preparation for the upper bed.

Various plans have been suggested and tried for applying the spare heat of the smelting furnaces for calcining, but in England fuel is so cheap that it is preferred to burn coal rather than to resort to new and cumbrous arrangements. In many cases the wear and tear of the new furnaces would be more than the saving.

Under a calciner are vaults, called cubs, into which the calcined ore is let down and left to cool.

A calciner is sometimes very much larger in the floor than the other furnaces. Each charge put in a large calciner will be about 4 tons of ore, fine dressed. It is first put on the top, and then passed in due course on to the upper floor, where the calciners are double. It is well spread over the floor, and about every four hours is turned over with a large rake, called a stirring rabble, introduced from the side doors. In six hours it is passed to the lower hearth through holes in the floor. In the first six hours' treatment little more is done than to warm the ore preparatory to the further calcining, as little or no chemical change takes place.

In the lower tier or hearth the charge is commonly left six hours, and is stirred every two hours; but as it is not stirred previous to discharge, it is only stirred twice. A charge is, therefore, passed through every six hours, but the time will vary according to circumstances. When the calcined ore is discharged into the cub, it is often cooled by water being thrown on it, and it is wheeled away to a heap for mixing, but in some cases is passed on direct to the furnace.

In smaller calciners than those here referred to, or in those of older construction, the charge will not be more than 3 tons or 3½ tons weight. A difference in weight of charge will be compensated by difference in the size of the grate and the quantity of fuel consumed, so that the dimensions of the calciners might properly be adjusted by the proportions of calcining to the total work done.

For calcining the quantity of ore here mentioned with four charges a day, about 1 ton of coal per day would be burned, or about a ¼ ton per charge of ore, or very nearly 1 cwt. per ton of ore; but as Sunday is a slack day, and the calciners are kept in heat, the rough consumption in a week may be taken at 7 tons, the number of charges at 24, and the weight of ore at from 90 to 100 tons. The number of working weeks in a year is about 48, but may be increased to 50.

If the ore calcined be a sulphuret of 10 per cent., though it is seldom so high, its constitution will be about (say)—

Copper	10
Sulphur	15 to 20
Silicious matter	45 to 55
Iron	20 to 25

About half the sulphur is expelled in the calciner or in the cubs, and a portion of oxygen is taken in and unites with the iron, and some chloride of sodium is obtained from the salt water thrown into the cubs.

Another class of ore may be thus composed :—

Copper	8
Sulphur	23
Silica	45
Iron	24

Mr. John Cameron, F.C.S., tabulates the result as follows :—

Original Form.		Converted into—	
Sulphuret of copper	8 copper.	8 copper	Sub-sulphuret of copper.
	2 sulphur.	2 sulphur	
Sesqui-sulphuret of iron	21 sulphur.	10 sulphur	Lost or replaced by
	24 iron.	5·40 oxygen	Sesqui-oxide of iron.
		12 iron	
		11 sulphur	Sesqui-sulphuret of iron.
		12 iron	
Silica	45	45 silica	

In working a calciner, three men are employed for the day and three for the night, each gang under the foremen of calciners. The men are paid by the watch, and not by the charge, the operation being one of unskilled labour, and not requiring to be stimulated by piecework. The wages are from 14s. to 16s. per week. There is, in fact, no definite rule as to the state of the calcined ore, as it is not required to be exhausted of the sulphur, nor is any assay made to ascertain its condition.

II.—Process.—Ore Furnace.

The second process is to put the calcined ore into an ore furnace.

The general form of a reverberatory furnace is about the same, and has remained so from the earliest period of the establishment of copper smelting in this country, by Sir Clement Clarke. Some old drawings of Cornish furnaces are much the same in principle and general details as those of South Wales or Liverpool now. Further confirmation of this will be found in an interesting article on the early copper patents of Sir C. Clerke, in the *Mining Journal* of Nov. 27.

A furnace consists of a flat egg of the strongest fire-brick, supported by brickwork of ordinary bricks. Into this egg a large grate discharges the flame of a powerful fire, which passes along the upper inner surface of the egg, and is carried up a narrow throat or flue. At the bottom of the egg is laid the ore or metal to be operated upon. Such is the general structure of a furnace, but its details must be more closely examined.

It will be seen that its chief constituent parts are the grate, the furnace or hearth, and the flue.

The grate is a smaller structure added to the furnace at its back, open to the furnace on one side, and having on the other three sides walls roofed in at the top, and open to the ashpit at the bottom. The size of the grate is chiefly dependent on that of the furnace, but it is varied by different engineers. According to an able practical authority, Mr. Alfred Trueman, C.E., the area of the hearth of the furnace being about 154 square feet, the area of the grate will be from 17 to 19 feet. The depth is not of so much importance as is the area of incandescent coal which supplies the flame. On one side of the grate is an iron feeding-hole. called a teazing pot, by which coal is thrown in. The grate is open to the furnace, but the communication is throttled by a thick wall, called a bridge, which likewise forms the dividing wall between the grate and the furnace, and rises above the level of the hearth of the latter.

The ashpit under the grate allows the furnace-men to get down not only to remove the ash, but to rake the fire from beneath.

The furnace is of an oval or egg-shape, but flat, and its capacity is diminished by sand-beds or bottoms. It consists, as already said, of a casing, which is formed of fire-bricks or silicious bricks, called the inside casing. The outer form of the furnace is, however, nearer to a square, and it is composed of less refractory bricks. This is called the outer casing, and the intervals between the inner and outer casings are filled in with old bricks.

On the hearth or floor of fire-bricks of the furnace, as already said, a bottom is raised for its protection. When a new furnace is started it has to be annealed. This is done by keeping up a fire in the grate for about a fortnight, with the doors of the furnace off. No bottom has yet been put in. The doors are put up, and the furnace tested with a few hours' good heat, to see whether there are any flaws or air-holes; if found all right, and while the furnace is hot, a little slag—say, sharp slag—is melted on the top of the bricks of the floor—say, 2 inches in depth. Some sand is then thrown in gradually with the slag, the furnace being still in heat.

The first bottom is then put in, being fire-sand to the depth of about 18 in.; it is calcined for two hours, whereby the sand is consolidated, and the specific gravity increased. The men then level it with a rabble. The bottom is then smoothed down with a beater, giving it a little fall to the tap-hole. The doors are then put up, and a strong heat is kept up for 12 hours. A little metal or ore is next thrown in, which is melted in (say) a quarter of an hour.

The sand is then thrown in for a second bottom, to a depth of (say) 4 or 5 in., and this is calcined for four hours. It is then levelled with the rabble, and smoothed down with the beater, as before; the doors are put up, and the bottom is melted for 10 hours, and next the doors are taken down, and some metal is put on and melted for (say) half an hour. The doors are taken down, and the furnace cooled black—that is, to a dull red heat—for three or four hours, when a full charge is put in and melted, and the furnace is cooled down again, and next three charges are melted in succession. This furnace is cooled down again, and thenceforth thoroughly started. The bottoms constitute one of the most essential details in the working of a furnace. In South Wales blown sand (or sand driven on the shore by the wind) is used, because it is nearest at hand and readily obtained. As much as 70 wagon loads a day are used by some works. This sand is inferior, because it is mixed with shells consisting of lime, which flux, but it is supposed that in the blown sand the shells, being lighter, are winnowed, and that the proportion of silex is larger.

Abroad shore-sand cannot be used, and fire-sand is imported from England. Fire-sand is likewise employed in some of the Welsh works. Such sands are found in several parts of South Wales, near Swansea and Neath.

This is nearly silicious, but shore-sand blown is thus composed, according to one analysis:—

Quartz and silica	86
Lime	5·7
Magnesia	·8
Alumina	1·6
Oxide of iron	1·2
Carbonic acid, traces of water, &c.	4·5

The following are notes on some fine sands, obtained inland, and used for bottoms :—

No. I.—Cwm Joy, near Swansea		Silica	92
„	„	Iron and lime	11

This proved very bad, and, while used, came up almost every week.

No. II.—Sand from near Briton Ferry, and Neath		Silica	92
		Iron and lime	8

This did well.

No. III.—Pembre		Silica	93
„		Iron and lime	7

This worked very well.

Iron is considered more objectionable in bottom sands than lime.

The consumption of best fire-bricks yearly, in a furnace of the size recorded, including grates, will be between 7000 and 7500.

A single furnace of the size already given, and a stack 45 ft. high, used up

Best Welsh fire-brick	2,288
Best Scotch ditto	5,816
Common Welsh fire-brick	13,271=21,375

The bottoms in an ore furnace will often last twelve months, but in a like furnace seven bottoms have been put in in the same time. The only cause assigned for this latter case was, that a stream of air came in through a hole in a door, and regularly cut the bottom, which parted and came up. In a roaster, however, the bottoms are always giving trouble. It is always desirable to keep the lower bottom as long as possible, and only to replace

it when the furnace is out, or repairs are on hand. The lower bottoms may be worked for years. The upper bottoms may, however, require renewal in three days or in three months. The breaking of a bottom suspends the furnace for some time, as it has to be cut to pieces with flowing bars, and got up. Letting out a furnace only for a day causes such injury to the bottoms, that they sometimes have to be removed or renewed. This will happen at stock-taking, when the furnaces are let down. This is one inducement to keep a furnace always under fire.

These bottoms absorb a considerable quantity of copper, which is thereby kept locked up in the furnace, and which presents the double disadvantage of dead capital and of uncertain quantity.

The furnace requires a bin, or hopper, at the top, to put in the charge of ore, and has a tap-hole formed at one side, which is only opened for letting out the molten regulus. The front door, for stirring and rabbling, will be described with the flue.

The outside casings of the grate and furnace are not dependent solely on the cohesion of the bricks, of which the fire-bricks are cemented with fire-clay and fire-sand, but they are fastened by cast-iron studs or upright posts of iron, a foot or two apart, and bound together at the top by bars of iron, called cramps, or clamps. Thus, a furnace is bound together in an iron cage, but it does not, nevertheless, withstand the violent action of the fire.

The flue springs from the narrow front of the furnace by what is called the uptake, up which the flame proceeds, and the flame and smoke are thence carried to a short stack, or down into the central culvert. The front door of the furnace is under this flue in the front wall, and when the furnace is at work it is secured by a door or slab of fire-pottery, which can be removed, to enable the smelter to work the charge.

The grate is, as stated, a square hollow chamber. It has at the bottom two strong iron-bars or sleepers. Regular furnace bars are not used, but loose bars of old iron are laid on the sleepers. The place of furnace bars is really supplied by a clinker bed. The coal commonly used for smelting in South Wales, erroneously described in most works as anthracite steam-coal, include a considerable proportion of clinker, and advantage is taken of this to build up a porous red-hot substratum of clinker, by leaving always a considerable portion of clinker in the grate. On the top of this the coal is burnt, and the height of the clinker grate is kept down by getting out portions from below the ash-pit, and more particularly when a large clinker has been formed. It is for this reason that loose bars are used.

This clinker grate is porous, and has channels through it, up which the atmospheric air passes, and is heated before reaching the burning coal in passing thence to the furnace. When needful for this purpose, the clinker grate is opened up with a pricking bar from below. This method has one disadvantage, that small coal will run through a large channel without being consumed, but are wasted in the ashpit. This may be remedied by greater care.

One advantage of this method is, that almost any kind of coal or slack may be used for smelting. Generally the coal is the refuse of the collieries, if any vend can be got for the larger coal, and slack has been exported for foreign collieries. Any free-burning coal will do, if cheap enough, but if used alone it is rapidly burnt up. It will be seen that the coal has to perform a double function—to pour flame into the furnace, and to keep up the clinker grate, and, therefore, where it can be done, it is found most useful to mix a free-burning and binding coal, so that the latter may clinker and bind together, besides giving its share towards the combustion. A coal altogether binding can be worked, but is not found good. Anthracite does not work well. A good mixture is one of binding and two of free-burning.

The best coals, binding and free-burning, are perhaps those of South Wales. Newcastle has good free-burning and some binding. The Lancashire coals are inferior. Artificial fuel has been used, but there is a prejudice against it, as the men do not like to handle large blocks or large coals, but like to have them ready broken.

In our works the supply is mostly obtained from collieries leased by the copper companies, and as the best qualities are sold for shipment, the smaller coal comes cheap, and but comparatively little attention is paid to its quality or consumption. There is most frequently no choice as to quality, and it is so cheap that its consumption is not closely supervised. It is, however, very doubtful whether slack is really economical, for good coal forms smaller clinkers, having less refuse in it, and is more economical of coal, and whereas small coal and slack form very great clinkers, and interfere with the healthy working of the furnace; with good coal, the fire is pricked about twice in each watch, but with bad coal oftener.

With regard to the square form of grate, my opinion is that there is a space not fully occupied by the fire, which is lost, beside the grate being there liable to injury; and in 1855 I suggested that the back should be rounded, and which has been tried.

In working the ore furnace, the charge will vary according to the class of ores and the furnaces, and the weight according to the size of the furnace, from 3 to 3½ tons, or in large furnaces rather above, but dependent on the fusible proportions of the ore. Calcined ores are more favourable, but the practice is at this stage to introduce raw carbonates, so that the following will give a good specimen of a charge:—

Calcined ore	Cwts. 36	Raw ore	Cwts. 26
Sharp slag	8=44		
Add	26=70		

The proportion of sharp slag may be made much higher, and of course that of calcined ore.

Of this total weight, it is to be observed, the slag is seldom weighed, but is computed; the ore is counted to the men as 22 cwts. to the ton: 2 cwts. in some works, and 1 cwt. in others, is carried at once.

The mixture of the charges is one of the chief points in good smelting, and taxes the skill of the managers, for many classes of foreign ores are brought into our smelting works, and in some countries abroad a great variety of ores is found and smelted. In other countries the quality of the ores is tolerably uniform, and the course of working is very regular. Where new ores are received, several trials may have to be made before the working is good, and sometimes the charge is worse at the end of the time than in the beginning.

In the early stages of copper smelting the object of the manager is less directed to any operation on the copper—to the manufacture of copper, in fact—than to the manufacture of slag, for the removal of silex depends on a good silicate of iron being formed, which will freely flow out separate from the regulus. This is an essential point to bear in mind, for the slag may be pasty, and so carry off a portion of the metal, or it may be full of shots of copper, and so wasteful, while the object is to get rid of the silex with as small a quantity of the valuable article, copper, as may be. A good clean slag is, therefore, the satisfactory test of working, and the slags are anxiously examined by manager and men.

The charge of ore is put in through the bin or hopper at the top of the furnace, and is spread over the hearth, or rather bottom, with the rabble. The slag is thrown into the furnace, through a side door, in large lumps. All the doors are then luted on tight with fire-clay, and the charge is melted for about five hours, when the furnace-man starts his fire afresh.

About this time he begins the moulding of his metal beds, and his slag beds, which are formed of sand—the metal beds near the tap-hole, and the slag beds before the fore-door. Any kind of common sand, dry, will do for their beds, as the moulding is rough.

Commonly, about the end of five hours, the furnace-man takes off the fore-door, which is burning hot, with an iron rod. He stirs the charge through the fore-door with a long rabble down to the bottom. If the charge is all right and thoroughly melted, he puts up the door, and allows ten minutes for the metal to settle down to the bottom. The door is then taken down, and the slag is skimmed off with the skimming rabble through the fore-door into the slag-beds. The slag is run over the lower bar of the door, which is above the level of the bottom. The man can see the bright level surface of the metal, and observe by the eye whether it is clear of slag. It is his object to get the molten metal free from slag, and the slag free from copper; and more particularly as all slags found to contain more than an allowed portion of copper have to be smelted by him free of charge. These are the checks for good working.

The metal is tapped into the regulus into pigs, but not until there is enough regulus from several charges.

In this process it is sometimes necessary to add fluxes to the charge, as fluor-spar, lime, shells, shelly sand, cinders, and anthracite coal. Fluor-spar is obtained from Cornwall, and M. Le Play estimated the consumption in South Wales at 7800 tons yearly. At present some works use no spar, and others not more than 100 tons yearly. Shells are not used in this country, nor are carbonaceous fluxes esteemed.

Five charges can be put through a furnace in a day when the ore is good, and sometimes six. The work goes on night and day, except on Sundays. The men are paid by the ton of ore in the charges, the ton being reckoned at 22 cwts.; the rate is now about 1s. 6d. per 22 cwts., or 2s. 9d. per 33 cwts., and a man's earnings are about 28s. per week. The men are one for the day and one for the night. The men of neighbouring furnaces help each other. The consumption of coal working from four to five charges will be from 25 to 30 tons per week. The stuff put into the furnace will be, say—

Copper	10¼
Silica	55 to 65
Iron	34 to 39
Sulphur	7½ to 10½

The produce is—

Coarse Metal.

Copper	10½ to 11
Iron	10½ to 15
Sulphur	10¼ to 7

Slag.

Silica	55 to 65
Iron	24 to 29

with a trace of antimony and tin.

The slag is a proto-silicate of iron (34·62 protoxide of iron and 65·38 of silica), with nodules of silex embedded.

III.—Calcining Powdered Regulus in Coarse Metal.

One of the old processes was to run the regulus or coarse metal not into beds, but into a basin of water or cistern, in which it was granulated. A part of Napier's improvements consisted in dispensing with this by a chemical mixture, but Mr. Alfred Trueman further improved by stamping the regulus to powder.

The powdered regulus is put into a calciner, which is the same as an ore calciner, and the general mode of treatment is the same.

The charge put in is from 3 to 3½ tons, weighed out 2 cwts. at a time. The charge is put on to the roof, and so passed on to the floors. It is spread in the same way, and stirred every second hour. One charge is passed through in 24 hours, the calcining taking double the time of ore; at the end of the time the regulus powder is cast into the cubs. Some sulphur is discharged in the cubs in vapour, which is passed through the cub dampers into the culvert.

The weekly consumption of coal is about 7 tons. Inferior coal may be used for calcining ore or metal; bituminous coal will do for this.

Two men are employed for the day watch, 12 hours, and two for the night. Their pay is about 18s. to 20s. per week.

About six charges are passed through in a week; the powder calcined, being a regulus of (say) 33 copper, 33 iron, 33 sulphur, has lost the greater part of its sulphur, and acquired oxygen, forming oxides of copper and iron.

IV.—Melting Calcined Coarse Metal.

The furnace is the same as an ore furnace. The charge is made up to a total weight of about 52 cwts. There is here an opportunity of introducing raw ore again as rich carbonates, and the following will represent a charge:—

Calcined powder	Cwts.	24
Foreign raw ore		24
Refining, or roaster slag		4=52

Another example is—

Calcined powder	Cwts.	23
Foreign raw ore		24
Refining, or roaster slag		5=52

Another example is—

Calcined powder	Cwts.	20
Raw carbonates		20
Refining, or roaster slag		8=48

Of these the charge may be made up with calined powder and slag, and this is the case abroad, but English melters have to work up a great quantity of foreign ores, which they are thus able conveniently to introduce.

The ores in the charge are well mixed together in the ore-yard before being supplied to the men.

A charge is in about six hours, and is treated much in the same manner as in the ore furnace. The slag is skimmed in the same way, but the regulus, being more abundant, may be tapped every second charge.

The coal consumed is about 4 or 5 tons a day, or about 30 tons a week.

There is one man for the day watch, and one for the night watch. One furnace will pass through about 2200 tons of ore, holding about 700 tons of copper. The result is *blue* or *fine* metal and sharp slag.

The metal consists of—

Copper	70 to 83
Sulphur	30 to 17

The sharp slag consists of protosilicate of iron, with copper and antimony.

The slag is so called because it is bright, breaking into sharp-edged fragments. They contain no shots inside, but small shots sometimes on the outside.

V. Process.—Roasting Fine Metal.

A roasting furnace or roaster is the same as an ore furnace, but has no bin, as it is charged by the side door. There is an air-hole in each back corner, called a port-hole, which leads on to the furnace floor.

The charge put in is from 3 to 3½ tons of metal, rough weight, or enough to produce 2½ to 3 tons of copper. The charge is in about 24 hours. Each pig of metal is put in with a paddle. The portholes are partially opened, and fire is gradually raised for the first eight hours, and the metal kept red-hot. The fire is then raised a little for another eight hours, so that the metal will sweat down. The port-holes are closed and the doors luted tight, when the fires are raised and driven on until the charge is thoroughly melted on the bottom. About the 19th or 20th hour the front door is taken down, and the metal is stirred with a rabble. If all appears clean the small quantity of rich slag produced is skimmed, and if the metal be clear it is tapped, if for export, as in foreign works, into iron moulds as pimpled bar copper; but if to be carried to refined it is tapped into beds as pigs for the next roasting.

The quantity of coal consumed is from 22 to 25 tons per week.

The men's wages are about 3s. to 3s. 6d. per watch.

VI. Process.—Second Roasting.

When fuel is abundant and working careful the metal is subjected to further treatment, and sometimes to a further roasting of 12 hours.

VII. or VIII. Process.—Refining.

The refinery furnace is the same in form as the ore surface, but is smaller, and has no bin or tapping-hole, being charged from the side-door, and ladled out from the fore-door.

The charge in a refinery furnace will vary from 5 to 6 tons of pimple copper in pigs. One charge is put in each day. The metal is melted fiercely for several hours and skimmed for the slight slag. Air is let in from the side door till the copper begins to "work," or coil up, and when the refinery-man, with a little rabble, moves or flaps the surface a little. The "working" is continued for two hours, when the copper is seen to "blister," or rise in black scales, having become blistered copper. The man keeps the side door down, and lets the copper solidify according to circumstances, 2, 3, 5, 6, or 7 hours. The doors are then luted, and the metal melted afresh for 3 or 4 hours.

The head refiner now takes charge of the operations, and proceeds to take a small test in a ladle, which is worked into an ingot and tried on the anvil. If found fit, lead is put into the surface, about 16 lbs. to 6 tons of copper, and some charcoal is spread over the surface of the copper, and, further, the copper is stirred with a stout pole. He continues to test the copper, and as he finds the "pitch," or grain, so he backens or forwards the operation, and gives air, or poles more.

The refined copper is cast into ingots, tiles, or wire bars, according to the demand. It is sometimes refined a second time, if "best select" is to be produced. In making bar-copper for sale on a large scale, it is a practice in some countries to mark the bar with the maker's name in the casting, and likewise the number of the charge, so that a quantity may be dealt with as of one make. Sometimes the number is punched.

Bar-copper is sampled for sale according to a plan practised by Mr. Hussey Vivian, by drilling a hole of from ¼ to ½ inch diameter, half-way through the bar from the top, and another half-way through from the bottom, but not so as to meet, as they make two half-sections, and thus afford a better average section. The drill is worked in a frame. The fillings so obtained from each bar drilled are divided into four parts, a, b, c, and d; a and d going to the buyer, and b and c, as samples, to the seller, and from the total samples is taken, alternately, a check sample, under the seals of the buyer and seller. The drilling is rapidly done. The quantity taken is about 1 dram for each cwt., where the bars are of one charge or smelting, so that the total shall not be less than 240 drams or 1 pound weight, all the drillings are well mixed together. The drilling from 4 cwts. would be 240 drachms, and from 16 tons of the same charge about 320 drachms.

Furnaces.

A double-bedded single calciner, 30 feet long over casings, exclusive of grate, and 14 ft. wide, will require, besides the bricks of the stack or culvert, about 50,000 bricks, fire and inferior qualities, but in which old bricks can be worked up; 2 tons of best fire-clay and 8 tons of common fire-clay; 80 bushels of lime; 120 bushels of sand; a small quantity of fire-sand; about 40 tons of stone for foundation (but this depends on circumstances); of sundry clay pottery, 200 or 300 soaps, and as many splits; 20 slabs and 20 bearers. The wages will be—mason 156 days, boy 156 days, labourer 48 days, besides head masons and smith for the smiths' work. The time in building will be about 20 days, exclusive of odd jobs in finishing off and setting the calciner going.

The ironwork for such a calciner, consisting of cramps, studs, door frames, plates, bearing-plates, sleepers, teasing hole, sliding frames, and slides, will vary according to the mode of construction adopted in the several works. The smiths' time in fitting will be seven days, and a labourer seven days.

A single double-bedded calciner will take about 24,000 fire-bricks and 1200 red bricks, 2 tons of best fire-clay, 8 tons of common clay, and other materials as before. The labour will be less, both of masons and smiths, in proportion to the difference of materials. The grate will be about the same as the grate of a furnace of like dimensions.

The stack will be the same as for other furnaces, and its cost will be according to the system of stacks adopted.

Furnaces are worked with stacks according to various plans, depending on the circumstances of the works, or on the fancy of the owner, manager, or mason. Some work the furnaces with a stack for each pair of furnaces, and some have all the flues brought by an underground culvert to one central stack. In the Cwm Avon Copper Works of the Copper Miners' Company of England there is not one stack on the premises, but all the furnaces communicate with one common culvert, which is carried for a distance of about a mile and a quarter up the side of the mountain, whence the smoke is carried up a stack 40 feet high on the top, forming a conspicuous sight for miles around, and with a draft strong enough to carry a man up into the air. This volcano can be seen for a considerable distance on a clear night, and on a fine day from as far as Tenby. A man took a contract for clearing out this culvert, on condition of having the culvert stuff for his remuneration, presuming that it contained the usual average of copper throughout, as a considerable quantity of copper goes up the stack. The contractor, however, made an unfortunate bargain, and abandoned his contract, as the chief stuff was sulphur and arsenic.

In some works a central stack and single stacks may likewise be found, but the balance of experience is not in favour of either system so as to secure its decided adaptation. The objection to a central stack and long culvert is, that the draft of individual furnaces is sometimes interfered with, and, therefore, stacks for each furnace are by some preferred. The advantages claimed for the central stack and culvert is, that an inferior draft is obtained, and that the copper passing out of the furnace in fume is saved; it is certainly true that in a single stack but little stuff is saved, whereas in a culvert there is always stuff containing copper which can be smelted.

An objection taken to a central stack is, that is may interfere with the working in case of repairs, but if there be one line of culvert running between the furnaces, and at each end of the culvert a high stack, then, by means of a brick partition set up in the culvert, the number of furnaces to each stack may from time to time be variously apportioned, particularly during the repair of end furnaces, then all the remaining furnaces may be put on one stack. The draft of a central stack will be affected by the greater or less number of furnaces working on it, and this is felt to be an inconvenience by the smelters.

One circumstance that will affect the height of stacks is the situation of the works. A number of high stacks belching forth sulphur and arsenic night and day destroy the vegetation of the neighbouring fields wherever the pestilent breath touches, the fields being stripped of herbage as if by locusts, and brought to the appearance of a bed of shingle. Copper works are, however, mostly situated in waste districts.

Much attention has been given to this evil, and the great waste of sulphur and other substances carried off in smoke, and many plans have been proposed for their recovery, but as yet no particular result has been obtained. There is no question that the loss is very considerable, forming part of that great waste of residuary matter which meets with too little attention in England.

A stack 50 feet high, and with an inside lining of 50 feet and outside lining of 30 feet, will, exclusive of foundations, require 3100 fire-bricks for the inside lining, and 2500 common red bricks for the outside; 2½ tons of common fire clay to be used inside, up to a height of 30 feet, 20 bushels of lime, 40 bushels of sand, and a little fire-sand for mixing with the clay. The wages will be—mason, 25 days; boy, 25 days; and labourer 21 days, besides superintendence. The time in building will be 9 days. All this is exclusive of foundations, which vary according to situation.

Such a stack is rodded or cramped with iron rods, for better security against the action of the furnace flames passing through, and there will be used 530 feet—⅝ × ⅝ square, for rods, 400 feet 1¼ × ¼ flat for cramps, and 200 feet 3 in. by ¼ flat for cramps, beside ¼ cwt. for wedges. The smith and his labourer's time will be 9 days.

The cost of a furnace will vary according to its purpose, its situation, and its dimensions. The following is for a large reverberatory furnace:—Outside dimensions over casings, 22 ft. 6 in. in length, and 15 ft. in width; add for grate, 6 ft. 2 in. in length, by 8 ft. 8 in. in width. Height of casings, from the floor at the grate end, 5 ft. 11 in.; at the fore part, 4 ft. 6 in. Inside dimensions of furnace, 14 ft. in length by 11 ft. in width. Thickness of inner and outer casings at the side, 2 ft.; of jambs and sides of grate, 2 ft. 1 in.; of back of grate, 9 inches.

Such a furnace would require about 8500 fire-bricks, and 3500 common red bricks, and about 3000 old bricks might be used up; of fire-clay, best 4 tons, and common 7 tons; of lime, 80 bushels; of sand, 120 bushels, and a small quantity of fire-sand; of pottery, 200 soaps or closers; 200 splits; 8 slabs, of various dimensions; and 12 bearers, whole or in halves. The wages will be, mason, 60 days; boy, 60 days; labourer, 60 days, exclusive of superintendence. Such a furnace can be built in 10 days, exclusive of odd jobs and finishing off.

The iron-work for securing the furnace will be as follows:—*Wrought-iron*, 260 ft. 1 × 1 square bar, 100 ft. ½ × ½ square bar, 100 ft. ¾ × ¾ square bar, 26 ft. 1½ × ¾ flat, 100 ft. 1½ × ½ flat, 80 ft. 3 in. × ¾ in. flat; 8 ft. 1½ × 1½ square bar; 4 studs 9 ft. long × 3 × 3 in.; 2 studs 5 ft. 6 × 3 in. × 3 in.; piece of wrought-iron 5 ft. 3 in. × 3 in.; teazing-pot; stuff for wedges. × *Cast-iron:* 14 studs 6¾ ft. × 3 in. × 3 in.; 7 studs 6 ft. 3 in. × 3 in. × 3 in.; 12 studs 5½ ft. × 3 in. × 3 in.; 1 bearing-plate 6 ft. × 9 in. × 2 in.; 3 sleepers 6 ft. 4 in. × 4½ in. × 2½ in.; 1 bearing-plate 7 ft. × 9 in. × 2 in.; 1 concave or convex plate 7½ ft. × 30 × 3½ and 1½ in.; 2 fore-plates 5 ft. 20 in. × 3 and 1½ in.; 2 skimming-plates 3 ft. × 7 in. × 3 in., made in three plates each. The wages will be—smith, for fitting, 14 days, and his labourer 14 days. The particulars and dimensions of this iron-work will vary according to the fancy of each manager.

In some of the latter works the furnaces are still found cased in a jacket of thick iron slabs, secured by the studs; but it is not a good plan, as defects in the brick-work cannot be so well seen, and air-holes may thereby escape notice, nor is the furnace stronger, cheaper, or more durable.

A furnace exposed to the intense heat of copper smelting is always in process of consumption, and its repairs are continual. The outside casings will last five years, which is about the longest life, but the inner portions are perpetually burnt up. A grate will last at the least eight weeks, at the longest thirteen weeks, so that there will be six grates in a year. The inside of an ore furnace, with repairs, will last from eighteen months to two years, but of a metal furnace only from nine to twelve months.

In a subject so extensive as this omissions are more likely to be noticed than what is described, but the commercial portion of the transactions is both important and considerable, and would require a paper by itself; and it is the more deserving of notice because the profits of the copper business depend more on good trading than on manufacturing cleverness.

The following is an analysis of select copper:—

Copper	99·80 to 99·85
Iron	0·10 to 0·15
Lead	nil. nil.
Antimony	nil. nil.
Oxygen, of no consequence.	
Silver, ditto ditto	

Select copper, as follows, will not sell:—

Copper	99·85
Iron	0·10
Antimony	0·01

Or even a trace of antimony.

The following is an analysis of the very best cube copper:—

Copper	99·60 to 99·70
Iron	0·10 to 0·15
Lead	0·10 to 0·15
Antimony	0·04 to 0·06
Silver (objectionable.)	

The paper was illustrated with specimens lent by Dr. Percy, Govern-

ment School of Mines; Mr. Gilbertson, managing assistant of the Corporation of the Governor and Company of the Copper Miners of England; Mr. E. J. Cole, of the Alten Mining Association; Mr. T. Hancock, manager of the North Rhine Copper Mining Company of South Australia; and with drawings on a large scale by Mr. Hyde Clarke.

After the reading of the paper, there was a very interesting discussion, in which Mr. CHARLES LOW, Mr. J. A. PHILLIPS, Mr. J. H. MURCHISON, Mr. P. L. SIMMONDS, Mr. JOHN BETHELL, Sir THOMAS PHILLIPS, and Dr. HYDE CLARKE took part: this we shall give fully in our next Journal, accompanied by some further general remarks on the subject.

NOTES ON METALS AND MINING.—No. IV.

The mythical account of the Argonautic expedition to Colchis, in search of the golden fleece, would bring the history of mining enterprise back to the remotest periods of antiquity; and the occurrence of gold near the roots of trees seems to be alluded to in that fabulous record. The great antiquity of mining enterprise with the ancient Greeks may be inferred from the circumstance that many of the mines which were worked by them were considered as exhausted as early as several centuries before Christ (for example, the mines of Lauricus); and a circumstance which is recorded by Strabo, that it was worth while to resmelt the slags of the old furnaces, affords evidence of their experience in the art of smelting.

The mines of ancient Egypt are mentioned by Diodorus and Agatharchides. Some mines which were being worked before the commencement of our era are still yielding returns at the present day; such, for example, as the quicksilver mines of Almaden, in Spain, which were known and yielded returns as early as 500 B.C., and from where, according to Plinius, large quantities of cinnabar were exported to Rome. The iron mines of the Island of Elba were likewise worked by the Romans; and the antiquity of the tin mines of this country has already been alluded to. It is a singular circumstance that Ireland, where mining enterprise has been slumbering until a comparatively recent period, should have been famous for its mines several centuries before our era. From a passage in Livius (*Hist. Rom.*, I., xxxii.), where he states that the questors had declared the silver paid as tribute by Carthago impure, because it had been found to lose one-fourth in weight when it was put to the test by fire, we might infer that the art of separating silver from lead could not have been unknown to the Romans.

During the middle ages, when metallurgy seems to have been the sole occupation of the chemists, or rather alchymists, the art of assaying and smelting seems to have been best understood and practised in Venice; while the cradle of the art of mining was Germany, where, amongst others, the records of some mines in the Hartz Mountains reach as far back as the tenth century.

Amongst the various mechanical and chemical contrivances which are resorted to by the miner in the prosecution of his calling, the pick and gad (from the Cornish *geds*, a wedge), and, probably, the crowbar, are the simplest and most ancient. Another very ancient method of facilitating the breaking of rocks is fire-setting; that is, piling a quantity of wood against the rock that is to be broken, and setting the same on fire, the heat of which, by acting upon and expanding the moisture in the rock, and, probably, by influencing its sulphuric, arsenical, and other components, causes the rock to become loosened in its joints, so that it could easily be broken down. Another contrivance, before the introduction of blasting by gunpowder, was to drive wedges of dry willow wood between the joints, and causing them to swell by pouring water over the same, after having covered them with wet rags, or turf, &c. This latter method may still be found advantageous in ground where it is unsafe to blast by gunpowder; and of equal advantage in similar kind of ground might, under certain conditions, be the employment of quick lime,—that is, the hole, or joint, is filled with quick lime, covered with tamping, and water is then introduced, which, in combining with the lime, causes heat, resulting in a tendency to expand and dislocate the joints.

Blasting with gunpowder is asserted to have been practised as early as the 15th and 16th centuries in the mines of the Hartz Mountains; but it appears that it was only resorted to in open surface workings, for it is only in the first half of the 17th century that we find it to have been resorted to underground (in 1613, for the first time in the district of Freiberg, in the Hartz Mountains; and in Schemnitz, in Hungary). In 1644 there were fired at Freiberg 63 shots, about 3 lbs. of gunpowder being required for each charge, the price being three guilders a piece. Blasting with gunpowder in this country appears to have been introduced by some German miners who were brought over by Prince Rupert in 1670, and who worked at the Ecton Mine, in Staffordshire. A most singular expedient resorted to by miners has been noticed in some mines in Norway, where the miners frequently construct arches, &c., by filling the space between the two walls with pieces of ice, and causing them to freeze into one solid mass by pouring water over them, thus contriving to enlist in their service the very severity of the climate.

But to English miners belong the credit of having been the first to enlist in their interest that powerful mechanical agent, the steam-engine. The first steam-engine on a mine was erected between the years 1710 and 1714; the second at Wheal Fortune, in Ludgvan, in 1720. It is interesting to observe that in very many instances the productiveness of mines has steadily kept pace with the improvements in the steam-engine, and the corresponding facilities which thereby were offered to the miner in his endeavours to fork the water, whose abundant presence in almost every deep mine constitutes one of the greatest drawbacks in the progress of mining. And this circumstance affords an instance of the vast and important influence which the various improvements and discoveries in mechanics do, and may be made to, exercise upon the development of the art of mining,—an influence which, there is every reason to believe, will in the course of time extend itself further and further, and which some day may tend to reduce considerably the toil and fatigue, and decrease the risks, which a working miner of the present day has constantly to undergo.

Attempts have been made to estimate how long the deposits of coal might continue to supply the increasing demand for fuel, and the time has been calculated when those deposits would become exhausted; but if now the results of such attempts with respect to the comparatively well-defined and known coal deposits are rather vague and uncertain, it must naturally be a far more difficult task to estimate the extent and durability of metallic deposits. Taking for granted that there will come a time when almost every part of the globe will be inhabited by a dense and civilised population, and when the supplies of metals now yielded by some new countries will be consumed on the spot, we nevertheless do not fear that at such a far distant period of time the demand for metals will exceed the supply, because in a corresponding increase of commerce, and the rapid improvements in the various means that support and facilitate the same (including the increasing rapidity of communication between distant lands) in the steady and sure advance of the art of mining and all its allied arts, and, above all, in the progress which science is continually making, by whose discoveries man is enabled to extract useful metals from substances that exist in abundance around us (for example, the modern discovery of aluminium), and to supplant rarer and more costly metals by alloys, &c., of cheaper and more abundant metals; in all these we can trace manifold proofs of the ceaseless care of a kind Providence, in laying up vast stores of material for the use of future generations, and in gradually guiding the human mind towards the knowledge how to utilise the same, so that, however disproportionate the relations between the rate of consumption of metals and the slow magnetic growth of new metallic deposits in the depth of our terrestrial surface may be, still it need not be feared that, even after the lapse of thousands of years, the human race should ever be in want of metals.

LONDON TO AMERICA IN 110 HOURS—IRON SHIPBUILDING ON THE TYNE.—We are glad to learn that the Atlantic Royal Mail Steam Navigation Company (Galway line) have given their first contract to Messrs. Palmer and Allport, steamship builders, of Newcastle-upon-Tyne, for three powerful express steamers, which are promised to be superior to any afloat, and to have a guaranteed minimum speed of twenty statute miles per hour. This order far exceeds any other that has been undertaken in steam navigation, and it is impossible to exaggerate the importance of it to this locality. The length of these vessels (which are to be paddle-wheel steamers) will be 330 ft., and breadth of beam 38 ft.; their engines will have three oscillating cylinders, each 75 in. diameter, and upwards of 2200 indicated horse-power. They are intended to run between Galway, St. John's, and New York, and to convey only passengers and mails. The minimum speed, as it has been stated, will be twenty miles per hour, in smooth water, although much more is anticipated; and, no doubt, the distance from Galway to St. John's, in moderate weather, will be accomplished in from four to five days. The size of the steamers will be better understood by the parties in this locality when we mention that they are nearly 20 feet longer than the *Hudson* and *Weser*, the two splendid screw steamers lately launched at Jarrow, from the yard of this enterprising firm; but these vessels only attained a speed of 17½ miles per hour on a trial made before they received any cargo. The accommodation is intended to be of the most complete description, the first saloon being calculated to dine 200 passengers; and berths will be fitted to accommodate 300 third-class passengers. This immense undertaking will give employment during the next year to upwards of 3000 men at Jarrow alone, and in addition hundreds will be employed by Messrs. R. and W. Hawthorn, who, with Messrs. J. B. Palmer and Co., have the building of the huge machinery to propel these floating monsters. We congratulate Messrs. Palmer and Allport on their success in the competition for this large contract, which it was well known was very great from the Clyde and other places; and after the magnificent productions which have lately been launched from their building-yard, it is not too much to say that it could not have fallen into safer or more competent hands. When these vessels are placed on their line, the distance to America will have to be reckoned by hours instead of days as heretofore. The London and North-Western Railway Company have undertaken to convey the mails from London to Kingstown in eleven hours; thence to Galway will occupy three hours more, and if we take the sea voyage at four days, as we believe may be safely done, America will be reached from London in 110 hours! This seems marvellous indeed, but will be accomplished beyond all doubt; then who will not visit the western hemisphere, and see his Yankee cousins in their own country?—*Newcastle Chronicle*.

CORNISH MINE PHOTOGRAPHS—SECOND SERIES.—No. VIII.

REDRUTH MARKET DAY.

An ancient writer says—"Tell me who you are with, and I will tell you what you are." This is only an axiom, and not a truism as is generally supposed. The witty Sidney Smith observed, that "If a man be born in a stable, he need not therefore be a horse." Diogenes, when seeking in the market-place at Athens, was not necessarily a "Cheap John," though it is proved he carried a lanthorn. Nor are we at Redruth doing more than a cosmopolitan visit, to observe the ways of men now at Redruth, and compare them with the former days, "when we went gipsying, a long time ago." Another author says, "The best criterion of a people's welfare is to study the comforts they possess, and the means they have of obtaining them." This is true political economy, for if the mass have the means of common comforts, the aristocracy have easier minds; if, on the contrary, the people have not the facility of obtaining the necessaries of life, and that, too, by ordinary exertion, something must be wrong, and vows not loud but deep will be engendered—"A leary belly makes a saucy tongue."

We are led to these observations by spending a day at Redruth, and contrasting its present state to what it was in our youth, some forty years since. It chanced to be on a Friday, the market day at this now really fine town. After considering its present flourishing condition, we reflected whence all this? To this end we called on several shopkeepers, making trifling purchases, for the sake of enquiry, when we invariably found them regretting the good old times "what was," and waiting for the good time coming. True is Pope's line—"Man never is but always to be blessed." We now but apostrophise; we must to our purpose. Well, to begin at the beginning. We look out of our hotel window, and see two robust tradesmen in the street, one a knight of the cleaver and the other a boniface. We unwittingly hear the common observation of "Fine day, Sam." "Iss, Sir; I believe we shall have a good market. Tin is rose, and the standard was up yesterday. They do say that Carn Brea is cut rich, and Buller is better in the bottom. We shall have good times again in Redruth yet." At uttering this his countenance was lit up with good humour; and the innkeeper's jocund assent testified his gratification, as he sped back to his hostelry of the Red Lion.

We laid down our razor without effecting our purpose, to reflect on the scene open before us; and, wending our way to the spot we had determined to be the scene of our day's observations, noticed first the supply and suppliers of the articles on sale. These we found so multifarious, and from so many parts, that, like the bellman of the town, who too was overwhelmed with business, declined reading the particulars of the handbill he was engaged to describe, as being "too numerous to mention." We found, however, that the prodigious quantity of comestibles, in one shape or the other, were derived from all points of the compass. That whereas thirty years since about ten butchers frequented the market, more than thrice the number now retail; that everything had advanced alike; that no such thing as barley flour was used. We then enquired, how is all this? when we were responded—"The mines, Sir, the mines." Here, then, was the grand secret—"The mines, Sir, the mines." Here was the golden key, the solution of all the comfort, and the source of all the wealth, prosperity, and happiness of which Redruth Market was such palpable and convincing evidence. Hark! what's that cry,—"Sheers! Sheers! Sheers!" We walk up to a curious conveyance, a pair of shafts, with a cross piece for the wheels to act on, and a couple of baskets (panniers) filled with the delicious pilchard and less luscious but equally grateful hake. This was the advent of a fish supply, equal in quality and variety, if not in number, to Billingsgate, the language of which celebrated community has been communicated by degrees, and beautifully less, even to this remote scene. This portion of the market is, shame to the authorities, carried on in the steep and narrow thoroughfare, to the annoyance of everybody, whereas a little vigorous effort, as at Penzance, would abolish the nuisance, without encroaching on "vested rights" in the slightest degree.

Here come the butchers, with their well-filled carts, robust, healthy faces, and clean blue frocks and sleeves, depositing, jointing, and putting the best side of all pieces "towards London." It is curious to witness the *modus operandi* of a Redruth butcher; to see how carefully he apportions a bit of bone with every joint, and to watch how nicely he weighs out every portion of fat with the lean. That part of it which with the London butcher best suits the chandler is here most in request. Yes; the tallow is the most valuable part. On enquiring why, we found it was used by the mining housewives for making pastry, in the shape of haggans, pasties, &c. "Haggans!" we hear exclaimed, "what are haggans?" Haggans, we are told, are haggans. But, oh, stranger! if ye list, oh, list! to hear of a dish which even Soyer, that prince of gastronomics, never thought of—"pilchards and leeks in a pie!" Oh, ye who never knew the joys, try it! Remember Redruth Market, there you can have both in perfection, as well as all the butcher's meat in due season, and in no town in the kingdom is it in greater abundance or of better quality.

Go we now into the streets, where, as I have before said, the nuisance still exists: over that we have no power of description—it is absolutely infamous. But here is our old friend Cheap John, from Sheffield, with his everlasting cargo of the last lot, and his eternal stock of stale lies and obscene jokes. Here, too, is our old, very old friend, the worm-doctor, with the veritable leather boot-string in a phial of cold water, representing in full the character of its charlatan master; being the true representation of the "black tape-worm," which, as he loudly exclaims, "eats a man's vitals hout." Here comes the last dying speech and confession man. Here the verses composed by one of the late sufferers at Porkellis Mine, now published for the sake of his afflicted family, price only one halfpenny. Oh, a rare market is Redruth! But, make way, here comes the king—no, the mayor in state. "Lo! he comes, from clouds descending." But here he is, and we must dilate upon his good qualities, as in duty bound. Well, his good qualities are patience, open ears and long, willingness to do any duty, under any kind of treatment; his only bad quality is obstinacy, and where is the potentate that is not ass enough to have that.

We walk through the market of well supplied vegetables and all other delicacies the most addicted *gourmand* could desire, and then we wonder how is all this profusion to be consumed? We visit the hotel. There we find Capt. Friggers shaking hands with Capt. Wilkins, still in earnest conversation with Capt. Pope; Capt. Pope having hold of Capt. Rogers's button; Capt. Rogers holding up his stick to Capt. Richards, who was hallooing to Capt. Cock not to go to bal till he had seen him. Here, thought we, is the great secret of all this bustle—Mining.

We enter the long-room, as it is called, filled with smoke, mine captains, brokers, greenhorns, &c. Our advent (being known) is the signal for general, not universal, salutation. "Well, old fellow!" resounds on every side. We sit down and enjoy ourselves for awhile—we are prone to fraternise: old Virgil, when describing a storm, said, "*Nil nisi pontus et aer; nubibus hic tubimus, fluitibus ille minax.*" This was a similar vortex, nothing but mining, or the price of wheat; all as it should be for a market; farmers and miners each driving his own, though very different, wheelbarrow. We, as in duty bound, having quaffed our malt, visit another hostelry; the self-same subjects, though in different hands, with a little dissertation, by way of amusement, on the prizes of the St. Leger, bull-dogs, and tin stealing, with a little local scandal by way of spice; as the latter became plenty we became scarce, and found ourselves at mine host's, where horse topics were uppermost for the time, which soon gave way to mining. We retired with the full conviction that mining only was the proper subject for Redruth; that the all-absorbing, that the parent, that the supporter, and that will be the end, of Redruth.

That mining may long be its glory, pride, and source, and that many more may emulate it, is the sincere wish of the miners' friend,

GEORGE HENWOOD.

CORNISH MINING MAXIMS.—No. IX.

"'Hold thy jaw, do,' says John Tregoning."*

This rather vulgar expression is but a reflex of the idea expressed some thousand years since by the poet Terence, in his proverb of *Ne sundas narrat fabulam*, "He knows not to what a deaf ass he talks." We should not have quoted the Latin apothegm, but to show the same animus is expressed in all ages in pretty nearly the same language. The John Tregoning alluded to was one of the old school of Cornish mine captains who, by dint of attention, raised themselves to fame, wealth, and distinction amongst not only their fellows, but are looked up to even by their superiors, yet still retain their original bluntness and coarseness of demeanour and language. This is too frequently cherished by them as a distinguishing feature, and is often regarded by strangers as a certain sign of originality and independence. Fortunately this feeling is on the decline on both sides, it being found that the gentleman of education, fine feeling, and polished language is not incompatible with the situation of mine manager or captain.

As we have said, the authority by whom the adage was quoted so frequently as to become a sort of addendum to the original was one of the class of captains nearly extinct. The saying is now confined to the lower class; still it is prevalent, and the ear is so frequently saluted with the sound that we sometimes are instinctively tempted to exclaim, when we hear persons who pretend to understand mining, for such there be (particularly in the metropolis), "'Hold thy jaw, do,' said John Tregoning." On such occasions was it the old 'cute miner was accustomed in polite society to utter the curt sentence.

The chatter of a magpie, the jargon of a parrot, or the rattle of a scolding woman's tongue, can scarcely be more annoying to an old experienced miner than the language and dictation to him of how to work a mine, frequently vouchsafed by the committee through their Chairman—the members of the said committee probably never having seen or known what mining is or should be, guided, as is frequently the case, by the mystification of a multitude of opinions and reports, or by a wretched and ruinous parsimony. When dictated to in such a manner, is it any wonder that the man of experience is ready to cry out in his vexation, "Hold thy jaw, do?"

It is much to be regretted that instances so much resembling the case above described do really so frequently recur; it is one of the consequences of the defective state of mine management. Too often is patronage, not ability, the stepping-stone to situations for which the employed are both physically and practically wholly incompetent; the natural consequences result; the affair gets into difficulty and disrepute; the mine becomes (though intrinsically valuable) a ruinous concern, the shareholders disgusted, and the agents dismissed. When the proprietors, deeming that in a multitude of counsellors there must be much wisdom, depute the entire management to a body constituted by them, who sit in conclave, and issue their orders from the "office," that the board will sanction nothing but so and so, that the expenses must be limited to so much per month. Oh! ye sages, could you but hear as we do the to you silent, but to us audible and significant, "Hold thy jaw, do," you would be more cautious on behalf of your own as well as your brother adventurers' pockets than you are of how you issue your edicts to direct experience and instruct ability.

To apply our rough subject to advantage from the above true statements, let us advise a contrary mode of procedure. Advance merit and ability to their legitimate positions, and let patronage of "Dowbs" cease in mining, at all events; it is not an employment for pedantic fops or Cockney amateurs—let mining be to miners. By doing so our phrase would grow into disuetude, and ultimately sink into oblivion, save that this sketch may rescue it as being amongst the list of Cornish proverbs, many of which are obsolete. Would this were so, as well as the practices to which it refers, and that we hear no more from captains' mouths in their vexation, "'Hold thy jaw, do,' says John Tregoning." GEORGE HENWOOD.

* Hold your tongue, do; or you don't know what you are saying.

FOREST OF DEAN.

Our former notice of Mr. Nicholls's "History of the Forest of Dean"* brought our readers to the period when the right to mine was restricted to the foresters. It was not intended that this order should always continue in force, but only until such time as the cause brought in the name of the foresters should be heard and determined. This, however, appears never to have been done, as no decree was obtained, probably from the miners considering it best to accept the terms offered, regarding the above order as a record in their favour, since it provided that "no new diggers were to be allowed, but only such poor men as were inhabitants of the said forest;" a view, it may be remarked, agreeing with that which the free miners took in their memorial of 1833. In 1637 a grant was made to Edward Terringham of all the mines of coal and quarries of grindstone within the Forest of Dean, and in all places within the limits and perambulations thereof, as well as those within His Majesty's demesne lands and waste soil there, as also all such as lay within the lands of any of His Majesty's subjects within the perambulation of the said forest, to His Majesty reserved, or lawfully belonging, to hold for 31 years, at a yearly rent of 30*l.*" The next year (1638) is marked by the first effort which the Crown seems to have made to renew the crops of timber in the forest, rendered necessary by the report that on surveying it, a supply of no more than 105,557 trees, containing 61,928 tons of timber, and 153,209 cords of wood, of which only 14,350 loads were fit for shipbuilding were found, as "the trees were generally decayed and passed their full groath." Accordingly, under the direction of Sir Baynham Throckmorton, 16,000 or 17,000 acres were ordered to be taken in, "leaving fit and convenient highways in and through the same." After sundry meetings the commoners consented thereunto, few or none objecting, in consideration of 4000 acres, set apart for their use on the different sides of the forest.

On March 18, 1663, there took place the earliest session of a local but very significant Court, that of the "Mine Law," whose date and proceedings have been preserved. It was held at Clearwell, before Sir Baynham Throckmorton, deputy-constable of St. Briavel's Castle, and a jury of 48 free miners, and shows that the forest miners of that day were a body of men engaged in carrying on their works according to rule, so as to avoid disputes and unequal dealing. The second existing order of the Mine Law Court states that it met in 1674, at Clowerwall, before Sir George Probert, deputy-constable of St. Briavel's Castle, with the design of raising a fund for defending, in a legal way, the rights of the free miners, and affording them support when injured at their work. A payment of 6d. per quarter was levied upon each miner digging for or carrying mineral, if 15 years of age, and also upon every horse so used, payable within 14 days, under a fine of 2s. Six collectors were to receive the above payment, to be remunerated at the rate of 1s. per quarter for each pound they gathered. Twice a year they handed in their accounts, under a penalty of 5*l.* and perpetual exclusion from any office of trust if such were found defective. The third Court was held in Sept., 1678, at Clowerwall, before Sir Baynham Throckmorton, whose favour the free miners were most anxious to preserve, since, upon understanding that the former order of 1668, forbidding any foreigner to convey or deliver minerals, had proved prejudicial to him and his friends, and tenants, they now revoked the same, allowing any foreigner to carry fire or lime coal for his own use; besides which they constituted the Marquis of Worcester, the then constable of St. Briavel's Castle, as well as Sir B. Throckmorton, his deputy, "free miners to all intents and purposes." The fourth Court, held in 1680, appointed six "bargainers" to deal with the difficult question of valuing the minerals offered for sale, inconvenience was yet experienced on this head. The fifth session confirmed, for the most part, orders already issued, and further exacted the payment within six days of 6d. from every miner 13 years of age and upwards, and an additional 6d. for every horse used in carrying mineral, "for raising a present sum of money for urgent occasions," and required all coal pits which had been wrought out to be sufficiently secured. The next important order is the seventh, which, amongst other things, directed that each coal pit and dangerous mine pit, if left unworked for a whole month together, should be fenced with a stone wall, or posts and rails, under a penalty of 10s. The seventeenth or last order issued by the Mine Law Court is dated Oct. 22, 1754. After recording the election of a number of persons of position and influence, it concludes by directing that the water-wheel engine at the Orling-green, near Broadmoor, be taken to be a level to all intents and purposes. This machine was evidently the first of its kind erected in the forest, as was also the steam-engine which superseded it, each manifesting the improvements going on in the method of working the mine.

There now remains to be recorded the history of a century, from 1758 to the present time, but we may consider that in tracing the various interesting particulars connected with the locality from the earliest periods to the closing of the last Mine Law Court, Mr. Nicholls has completed by far the most difficult portion of his task. The geological conditions of the Forest of Dean merit careful observation, not only as regards the mineral wealth comprised within its limits, but as explanatory of its undulations and the means of maintenance for its inhabitants. This strata of the forest repose in a basin-like form, the greatest depression being near the centre; the longer axis extending from north to south about eleven miles, and the transverse axis in the widest part ranging from east to west about seven miles. The principal iron mine train of the district divides into a lower or more crystalline, and an upper or more argillaceous and sandy stratum. Mr. Mushet remarks that "the iron ores of the Forest of Dean are found, like the ores of Cumberland and Lancashire, in churns or caverns formed in the upper beds of the mountain or carboniferous limestone. The leaner ores contain a great deal of calcareous matter in the shape of common limestone or spar, which reduces the percentage in the ore as low as between 15 and 25 per cent., and it seldom exceeds 25, except when mixed with fragments of what is called brush ore, which, when in quantity, raises the percentage to 40 or 45. Brush ore is a hydrate with protoxide of iron, and frequently, if not much mixed with calcareous earth, contains from 60 to 65 per cent. of iron. These ores are found in chambers, the walls of which are exceedingly hard limestone, crystallised in rhombs. This limestone is called the 'crease,' and is frequently found enveloped and

* "The Forest of Dean; an Historical and Descriptive Account, derived from Personal Observation and other sources, Public, Private, Legendary, and Local." By H. G. NICHOLLS, M.A., Perpetual Curate of Holy Trinity, Dean Forest.—London: J. Murray.

covered with the iron ore. The miner has to cut his way through this crystallised limestone, from chamber to chamber, a distance of from 20 to 100 yards before he reached the next of these deposits, which are sometimes found to contain 3000 or 4000 tons of ore. The principal part of the ore is then dug easily, somewhat like gravel, but the sides of the chambers are often covered with the stony ore before described, which requires gunpowder to detach it from the rock." The lower coal measures contain the lower and upper Trenchard veins, the Coleford, High Delf, with the Whittington and Nag's Head seam, which together give about 11 ft. of coal. The middle seams, not less than ten in number, are of the aggregate thickness of 20 ft. The heart of the forest basin is well defined by its forming a slightly varied plateau, containing the inferior and comparatively unimportant seams of Woor Green, situated, of course, nearer to the surface than the other veins, but as yet only sparingly worked, and not accurately defined in its outcrop.

We have thus endeavoured to give some idea of the contents of Mr. Nicholls's History, but it must be evident to all that in the space we have been enabled to devote to it we could give but an inadequate one. The locality has ever been invested with much interest, and every line of the book under consideration is worthy of perusal.

MINERAL LEGISLATION IN FRANCE.

The French Government has entrusted M. Lamé-Fleury, mining engineer, with the task of collecting and annotating the various laws, decrees, ordinances, decisions, circulars, and other public acts and documents on the subject of mining legislation, and the result is the production of two goodly volumes, containing much interesting and valuable matter.

A large number of works, official and non-official, has been published on this important subject in France; and the initiative now taken by the French Government deserves attention in England as well as in France; for it is scarcely possible that an enquiry into the subject on one side of the Channel can be conducted without affording matter worthy of attention on the other side.

M. Lamé-Fleury, who has been selected by the French Government to codify the laws relating to mineral property, is the author of a work on "Mineral Legislation during the Ancient Monarchy," and is evidently at home in his subject. This is indicated by the care with which the collection has been made, and by the notes and observations appended thereto by M. Lamé-Fleury.

It must have been no easy task to collect and arrange these materials for the history of mineral legislation, referring, as they do, to all kinds of experiments and contradictions, to conflicts between the Crown and the Parliaments, to opposition by individuals, who were sometimes supported by Parliament and sometimes repressed by force, and to disgraceful jobbery, with which some illustrious names are mixed up. If sometimes mining privileges were bestowed as a reward for public services—as in the case of the concession of the mines of Giromangy to Cardinal Mazarin—they were far more often obtained by favour or intrigue. The matter was strangely complicated also by the existence of a Grand Master of Mines, who sometimes granted privileges to one person, while the King, in council, granted like privileges, as regards the same property, to another. This office of Grand Master was last held by the Duc de Bourbon, and expired in 1740.

It is not surprising that such a system has given rise not only to innumerable disputes as to proprietorship, but also as to difficult questions concerning the rights of the Crown. It seems, however, to be pretty clear that the right of granting concessions of all kinds vested in the King; although for a short time coal mines were left entirely free, the abuses which grew up made it necessary for the Crown to interfere. M. Lamé-Fleury takes the reign of Charles VI. for his starting point, rejecting the period between that time and 1321, when some writers hold the first legislation on the subject commenced.

The King was Sovereign Master of Mines, but what was the exact nature of the right which appertained to the title can only be conjectured. The last exercise of the right recorded is a concession, in the year 1791, of mines of lead, tin, and coal in Cotentin.

A short time only previous to this period, Mirabeau, the most illustrious member of the Constituent Assembly, made his last speech there, and exerted his eloquence on the subject of mining property. He maintained that mines could not be looked upon as ordinary property, with which the proprietor could do as he thought fit, and that it was absurd to think of giving them up entirely to the first possessor, as Turgot had proposed; that they must be left at the "disposition of the nation," in this sense—that they should not be worked except by the consent and under the superintendence of the Government. This was the object of the law of 1791; but that law, in granting to the proprietor of the soil the right of mining to the depth of 100 ft., created new difficulties in the place of those which it removed. In the year 9 of the Republic a ministerial order corrected the law, but between 1806 and 1810 the matter was re-opened and discussed by the most celebrated men of the day, and, above all, by the Emperor himself, who, in the Council of State, like M. Mirabeau in the Constituent Assembly, threw the light of his genius upon the subject, and the result was the law of 1810. Under this law the mines neither belonged to the State nor to the proprietor of the surface. They became distinct and separate property, in virtue of concessions made by the Government, in which certain benefits were reserved to the State and to the proprietor of the soil.

We find that the Emperor more than once modified his views of the subject, and that much hesitation and doubt were exhibited in the debates, and the result must be regarded as a compromise of interests, and accordingly special charges have been made by the Government when granting new concessions, according to the circumstances of the case. One naturally asks whether all these interests have been equally protected—if, for instance, the proprietor of the surface is fairly remunerated by the payment of a few centimes *per hectare*, instead of receiving a certain portion of the produce of the mine itself? In some parts of France this latter arrangement exists; but these are quite exceptional.

The law of 1810, however, had this beneficial effect—it produced order in the working of the mines, they were brought under the eye of the Government, and it tended to the encouragement and protection of an industry which is exposed to many accidents and dangers. Capitalists received confidence, and although mining, like other undertakings, has suffered from the rashness or rascality of speculators or adventurers, it must be admitted that, under the law of 1810, the working of the mineral riches of the country has been pursued with praiseworthy perseverance. It must be confessed that the results have not been uniformly satisfactory; but the work is pursued with determination, and is extending into many new localities; and it is to be hoped that before long those who have embarked in the pursuit will reap a good harvest from their sacrifices.

A demand has been at times made for entire freedom as regards mining. Past experience affords little encouragement to the adoption of such a system, and the State cannot, in the general interests of society, abdicate its rights. Still many people believe that some change might advantageously be made; that, for instance, the concession of the mines might be granted to the proprietor of the soil, provided he gave sufficient security, and it is believed that the law of 1810 contemplated some such arrangement. But there seems a pretty general feeling that the working of mines ought not to be enfranchised from the control of the Government.

M. Lamé-Fleury has published also a work, entitled "Texte Annotté de la Loi de 1810," in which are contained all the administrative and judicial decisions pronounced between the latter year and 1257 inclusive; and the number of questions to which this one law has given rise is certainly astonishing. The work includes also a large number of documents, public and private, bearing on the question, and a list of the works previously published on the subject.

The law of 1810 is a fundamental law relating to mineral property. The law of 1838 gave the State the power of withdrawing a concession under certain circumstances; and the decree of 1852 settled a long-disputed question—whether the union of concessions required the consent of the State—in the affirmative; so that since this last date no concessions can be united together without the authority of Government.

The collection of documents relative to mineral legislation does great credit to the French Government and to the gentleman to whom the work has been entrusted, and by whom it has been so well performed. The subject is more extensive than would be included under the English equivalent; it comprehends mines, ores, turf, and peat pits, metallurgical works, dangerous, unwholesome, and disgraceable establishments, steam-engines, the sources of mineral waters, the statistics of mineralogical industry, geology, agriculture, workmen, schools, &c.—all, in short, that comes within the duty of the Ingenieurs de Mines, of whom Arago once said in the Chamber of Deputies, "I am pleased to proclaim that there has never been in the world—neither in times past or present—a corps which included so many eminent men."

It is impossible that a work of the kind we have named—referring as it does to so large a range of subjects, and running over so long a space of time, should not contain a considerable amount of matter that will aid the studies of all connected with mining, or at least with mineral, legislation in this country; and for this reason we have thought fit to draw the attention of our readers to this important publication.—*Building News.*

The Iron Trade in Sussex.—The iron trade reached its greatest extent in the 17th century, and as late as 1724 the iron manufacture was still considered the chief interest of the county, but the decline had already commenced. The vast consumption of wood rendered the production of iron in this district more expensive than in the localities where coal mines and iron ore are close together; hence competition with them became hopeless, though the works continued as late as 1750. Farnhurst, in West Sussex, and Ashburnham, in the eastern division of the county, were the last places at which they were carried on. The Ashburnham furnace was in work at the end of the last century. The principal existing remains of Sussex iron, besides the hooped guns, are—andirons and chimney backs, dating from the 14th to the 17th centuries (the work of these varies in character, but is sometimes very good and graceful), and monumental slabs, dating from the early part of the 17th century to the time at which the manufacture ceased altogether. One other relic of the Sussex works should here be mentioned—the balustrades round St. Paul's Cathedral, weighing together, with seven gates, about 200 tons, were cast in the parish of Lamberhurst, at a cost of 11,202*l.* 0s. 6d. A furnace near Mayfield disputes this honour, which really, however, belongs to Gloucester furnace at Lamberhurst, where the annual consumption of wood was 200,000 cords. Cannon cast in this furnace are said to have been conveyed by smugglers for the use of French privateers during the war with England. The discovery of this, it is also asserted, caused the withdrawal of many Government contracts, and the consequent decline of the works at Lamberhurst. The iron-works belonging to the Crown and to all the royalists were destroyed by Sir Wm. Waller after the taking of Chichester and Arundel in 1643. Mr. Murray's recently published *Handbook for Travellers in Kent and Sussex* gives some very interesting details. The period at which the iron of Sussex was first worked is quite unknown. The Rev. Edward Turner, of Maresfield, has, however, discovered Roman relics in a cinder-bed in his parish, indicating an extensive settlement. Many coins, mostly of Vespasian, Samian ware, and other articles, have been found here; and Roman coins have since been discovered in cinder-beds at Sedlescombe, at Westfield, and at Framfield (the cinders are the scoria of disused furnaces, and are now turned to account in repairing the roads). It is probable, however, that the Britons were acquainted with these iron fields before the Roman invasion. Cæsar describes the use of iron rings for coin, and asserts that iron was produced in the maritime districts, though in small quantity. It is not clear, through it is probable, that the ore continued to be worked by the Saxons. The iron beds of Sussex are not mentioned in "Domesday," although some others are. The earliest record of the works occurs in the murage grant made by Henry III. to the town of Lewes in 1266. In 1290 payment was made to Master Henry, of Lewes, for ironwork for the monument of Henry III. in Westminster Abbey; and 3000 horse-shoes and 29,000 nails are recorded as having been provided by Peter de Walsham, Sheriff of Surry and Sussex (13 Edw. II.), for the expedition against Scotland. Andirons and other articles of the 15th century are still found in some numbers in old mansions and farm-houses, and work of the 16th century is comparatively common. Some of the banded guns of wrought-iron preserved in the Tower of London, and dating from the reign of Henry VI., were of Sussex manufacture. A mortar formally remaining at Eridge Green, in the parish of Frant, is said to have been the first made in England, and it is probable that most of the pieces employed in our continental wars of the 14th and 15th centuries were manufactured in Sussex. These hooped guns were superseded by cannon cast in an entire piece, and bored, as at present. The first of these iron cannon ever produced in England were cast at Buxted, by Ralf Hoge, or Hogge, in 1543 (35 Henry VIII.) At the commencement of his work he was assisted by French and Flemish gunsmiths, but afterwards made by himself ordnance of cast-iron of diverse sorts. The trade increased rapidly during the 16th century, when many Sussex families enriched by it assumed the rank of gentry. John Nordon, in his "Surveyor's Dialogue" (1607), asserts that there were in Sussex nearly 140 hammers and furnaces for iron, each of which consumed every 24 hours from two to four loads of charcoal. The casting of brass was extensively carried on, and bell-founding successfully practised. A new peal for Eastbourne was cast at Chiddingly in 1651; the bells of Hailsham were cast on Bell Bank, a spot near the town. Steel was manufactured at Warbleton (where in a place called Steel-forgeland) and at Robertsbridge. The site of an iron-work was chosen near to beds of ore, and to some available water-power. Artificial ponds were generally constructed by dams of earth against the stream, with an outlet of masonry for the supply of water, by means of which the wheel connected with the machinery of the hammer or the furnace was set in motion. Many of the finest sheets of water in Sussex are thus due to the iron-works. Other meadows, once converted into ponds and pools, have again been drained.

WATERFORD AND KILKENNY RAILWAY.

The half-yearly meeting of this company was held at the London Tavern, Bishopsgate, on Tuesday, Mr. Charles Robert Colman in the chair.

The report of the directors and the various accounts were taken as read.

The Chairman said he had only to regret the shareholders had not more freely responded to the invitation to take up the new stock referred to in the report; and he believed that after the meeting was over, and when the shareholders had carefully read the report, they would more readily embrace the opportunity afforded them of taking up the proposed new stock. He had now merely to move that the report be received.

Mr. George Taylor: Before you put the report for the adoption of the meeting, I shall take leave to offer a few observations on behalf of a large number of shareholders in Ireland and here, who think, with me, that the affairs of this short Irish line should be wholly managed in the country from whence it derives its revenue; neither can I or they understand how it is that the shareholders in the Waterford and Kilkenny (who I believe are for the most part mercantile men) should so perseveringly desire that its management should continue in London. I can only account for such (if it be the case) by supposing some undue influence being brought to bear upon them, and that they are not in possession of the real state of their property. It appears to me contrary to common sense, as it is certainly opposed to all practical experience, so far as Ireland is concerned, that a railway, managed as ours is, could be worked with any prospect of advantage to the shareholders. I must ask the attention and indulgence of the meeting while I lay before them, as shortly as possible, some few of the facts with reference to this subject, which I trust will induce this meeting, and the shareholders generally, to concur with me, and aid me in removing the management to Ireland. We have 22 lines now open for traffic in Ireland, of these 18 are managed wholly in Ireland, and four in England. With reference to the 18 wholly managed in Ireland, one of them, with a capital of half a million, has paid a dividend for the last half-year at the rate of 9 per cent. on its capital, and 8¾ for the year. The share, or stock, of 100*l.* is not to be had under 190*l.* One has paid 5¼ per cent. for the year on its entire capital; four have paid 5 per cent. for the year; one, 4½ per cent.; one, 4 per cent.; one, 3¾ per cent.; one, 2½ per cent.; two, 2 per cent.; five, 5 and 6 per cent. on their preference stock; and one is not long enough opened to prove itself. Of the four lines managed out of Ireland, one of them, with a share capital of half a million, is totally unproductive, and the shares long since unsaleable. Another, the original shares totally unproductive, and the preference shares nominally quoted at 40 per cent. discount, but no sale. The third, which is at present totally unproductive, and the share 20*l.*, same as ours, nominally at 4, but no sale. This line, I understand, the shareholders contemplate a similar course to that which I now advocate. The fourth, and last, our line, the 20*l.* shares selling with difficulty at 2*l.* 5s., and the 5*l.* preference shares at 2*l.* 2s. 6d. Now, with reference to our line, all the money it ever paid out of revenue was about 2000*l.* Whether this was done legitimately or not I will not stop now to enquire; it cost 583,000*l.* for 29 miles, or over 20,000*l.* per mile for a single line of rails, imperfectly finished, while the South-Eastern, of which ours is a continuation, 26 miles in length, cost 262,000*l.*, or 10,000*l.* per mile, one-half the cost of the Waterford and Kilkenny; their shares of 12*l.* are readily bought at 7¼; they paid a dividend of 3¾ for the last year; their directors receive 250*l.* per annum; our 20*l.* shares are difficult of sale at 2½, and our directors take 400*l.* per annum, a charge which, conjoined with the London office, absorbs 700*l.* per annum. The South-Eastern receives 13,000*l.* per annum, clear of all working expenses, for 25 miles, while our line, for 31 miles, receive only 8315*l.*: in the former case, the line is between two inland towns, while our line has its terminus in Waterford, with all the advantages of steam navigation, &c.; the other terminus being common to both lines. Our law costs exceed 46,000*l.*, absorbing 9½ years of the average nett earnings. The last report shows 952*l.* 11s. 6d. under this head, being one-fifth of your nett earnings for the same period. The Cork and Bandon, lately managed in London, but now wholly managed in Ireland, has paid 5½ per cent. for the last half-year on its No. 1 preference stock, and 6 per cent. for the former half-year on its No. 2, preference stock, yet the directors take no remuneration for their services. This line, when managed here, did not pay 1s., and the shares, with 50*l.* paid, were selling under 4*l.*; they are now in demand at 105½*l.* The receipts since the management was wholly removed to Ireland have increased 25 per cent.; its working expenses for the last half-year are under 37 per cent.; the Waterford and Kilkenny are over 53 per cent.; the Waterford and Limerick, which is a continuation of our line, with all the disadvantages of the Limerick Junction station, have been only 44 1-6th for the last half-year. I will not occupy the time of the meeting by recapitulating all the blunders, or worse, which characterise everything connected with this line, from the time of its being laid out by a person representing himself as an engineer, but who was really a member of a very different profession. And it may serve to enliven the dulness of statistics to inform you, gentlemen, that he was a dancing-master (great laughter); and how he came to be chosen for the duties, I must refer you to the solicitors who were in office then as now. The consequence of this eligible appointment was naturally a detour of two miles unnecessarily round the River Nore, involving the cost thereof, and also the construction of a very expensive viaduct. People say this arrangement was for the benefit of a then director, who was paid for his land at a very high figure, and no doubt the solicitor could explain to you how it was that we had to pay twice for this land, as I have heard. The first contract was, most unfortunately, let to a very respectable man, but he was a builder or plumber. His first attempt at the construction of a bridge over the main road leading to Kilkenny proved a failure, for it fell, and greatly injured the line in public opinion. It ended, as all our contracts have done, either in law or expensive arbitrations. Then came the Prosser job, costing an enormous sum, in which the then secretary and some of the directors were said to have participated. Then the Burnettsiang job, together with all the misfortunes attending it, down to our late disaster at Dunkitt, all mainly attributable to non-resident and devided management. With all possible respect, our present board have not been a whit more successful than their predecessors; and if the true test—the market value—be relied on, the Waterford and Kilkenny has never been so low in the market as at the present moment. It strikes me it would be impossible to adduce anything more conclusive than these facts to show you that it is indispensible to make this change, now you have tried the London board for 13 or 14 years. Give the line, even now at the eleventh hour, a chance, and I have not a shadow of doubt, with honest local management, you will get a dividend on your shares at no very distant day. I ought to know Ireland well, having been professionally employed in nearly every county; and I confidently assure you that the Waterford and Kilkenny Railway could be made a paying line, notwithstanding all its misfortunes. Before I sit down I must express my thanks in the strongest terms to the meeting for the very patient, attentive, and encouraging manner in which they received my remarks. I now beg leave to move that it is the opinion of this meeting that a special meeting be called, to consider what course should be taken with reference to the future working of the line.

Three or four English shareholders rose together to second the resolution.

Several shareholders spoke, all strongly in favour of Mr. Taylor's resolution, and when it was ultimately put it was unanimously carried by the meeting.

The Chairman said the question before the meeting was that the report be received and adopted, and that motion had been seconded by Mr. Power.

Mr. Wildes said there was only one chance for the shareholders, and that was to remove them one penny for their property. He fully believed that if they got an intelligent, honest, and zealous board, their property was not so far gone but that it might be partially recovered at least, and that something would be left for the preference shareholders and for the ordinary shareholders. He thought the line had the elements of traffic in it, with the Port of Waterford at one end of it, and the town of Kilkenny at the other extremity.

Mr. Benson was favourable to the removal of the executive from England to Ireland. Past experience showed that it was a very great mistake that such a step had been so long delayed.

A Shareholder: Withdraw the 400*l.* to the directors; that is the first thing to be done.

Mr. Ald. Delahunty saw nothing to despair of in the case, if they met the difficulty boldly in the face. He alluded to the vast improvements making in Ireland in railway communication by various branches to fill up the network through the whole country.

Mr. Thos. Adams believed that injury had been done to the line by the local board in Ireland. He should be sorry to trust his interests to men who would not take up the debenture stock. If the shareholders did not come forward they would soon be in the hands of the Loan Commissioners.

Mr. Ald. Delahunty said he had no doubt that if the management were removed, that moment they would have the debentures taken up.

Some discussion ensued on the policy or impolicy of withdrawing the third-class carriages from the line.

Mr. Hill would be glad to see the views of the Alderman carried out. He was of opinion that the place to work out a line well was on the spot. But before they removed the executive, they must first secure the confidence of the large body of English shareholders, and they must hope for a large increase of Irish shareholders. He believed that the preference shares were an excellent investment, and that the line might be much improved. There could be no better port in England or in Ireland than Waterford. The railway had two most respectable towns at each end, and if Irish gentlemen in the vicinity would increase their stake, he would use all the influence he had to remove the board to Kilkenny, or Waterford (hear, hear); but a much larger stake must be taken up in Ireland.

The Chairman again put the motion, that the report be received and adopted, which was carried.—In answer to questions asked, it did not appear than any offers had been made to lease the line by the Southern and Western of Ireland, or the South-Eastern. The subject had been mooted in conversations, &c.

A Shareholder thought that, before the meeting separated, the directors should consider the propriety of abandoning their remuneration. He could not see the necessity of having a second board sitting in London, and thought that, in a small line like this, they should find a gentleman to act as secretary and manager. They must have a local management.—The report was ultimately adopted, together with Mr. Taylor's proposition, and the meeting separated.

Railways in Spain.—The development of the railway system in Spain is making considerable progress. Great activity prevails in the offices of the Spanish Crédit Mobilier, where the statutes of the North of Spain Railway Company are under preparation. Baron d' Eichthal and M. Duclerc have been commissioned to solicit Government approval of the statutes of the company as finally constituted. In the mean time the works are being carried on energetically throughout the line. The railways from Madrid to Saragossa and Alicante are being worked with advantage, alike to the undertaking and the public. The produce of the month of October, contrary to the experience of most companies, has equalled that of the previous three months, owing to the splendid weather which Madrid has enjoyed during October, and the traffic resulting from the return of families who had passed the summer abroad. The company has had to encounter a serious difficulty from the bad quality of the La Mancha water, which has proved injurious to their boilers, but to remedy this they have ordered an artezian well to be sunk at Albarete. The works of the Madrid and Saragossa line are actively pursued, and the section to Guadalajara is to be opened early in February. The presence of the Marquis of Corvera in the Ministry of Public Encouragement, is a guarantee that before next Cortes the important question of the Murcia line will be treated, especially as in the last Legislature a bill was presented by Deputy Barmevo and others, relative to a line from Madrid to Alicante, passing by Yecla, Jumilla, Cezar, and Cuenta, to the port of Carthagena. Murcia will soon have her railroad.

London: Printed by Richard Middleton, and published by Henry English (the proprietors), at their office, No. 26, Fleet-street, where all communications are requested to be addressed. [*Dec.* 4, 1858.